Evaluating survival and cause-specific mortality in adult and fawn white-tailed deer in northern and eastcentral Wisconsin

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Summary

- Three-hundred thirty-nine adult (≥ 18 months) and yearling (8–10 months) deer were captured with Stephenson box traps, netted cage traps, drop nets, and helicopter net guns.
- One-hundred fifty-one adult females were captured, of which 86 were radiocollared; 83 of 86 (radiocollared) females were implanted with vaginal implant transmitters (VITs).
- Pregnancy was detected with ultrasound in 77 of 83 (93%) adult females.
- One-hundred sixty-one and 36 deer were recaptured in northern and eastcentral Wisconsin, respectively.
- One-hundred four fawns were captured during mid-May through mid-June 2011, including 68 and 36 in eastcentral and northern Wisconsin, respectively.
- Twenty-two of 38 (58%) VIT searches resulted in the location of 22 fawns.
- As of 31 December 2011, 106 (70 males, 36 females) mortalities from adult and yearling radiocollared deer have occurred.
- Hunter harvest (38%) and predation (26%) were primary sources of adult and yearling deer mortality across northern Wisconsin.
- Hunter harvest (61%) and vehicle collisions (24%) were primary sources of adult and yearling deer mortality across eastcentral Wisconsin.
- In northern Wisconsin, 22 fawn (13 males, 9 females) mortalities have occurred through 31 December 2011; this represents 73% of the 30 radiocollared fawns. Most (64%) fawn mortalities were attributed to predation; bears and bobcats were primary predators.
- In eastcentral Wisconsin, 18 fawn (11 males, 7 females) mortalities have occurred through 31 December 2011; this represents 38% of 48 radiocollared fawns. Most fawn mortalities were attributed to predation (33%), starvation (33%), and vehicle collisions (17%).
- Vegetation surveys were conducted at 176 and 51 paired (e.g., bed site + random locations) fawn capture locations in eastcentral and northern Wisconsin, respectively, during June 2011.
- A white-tailed deer research website was developed during 2010.
- Thirty-two project presentations, 5 radio shows, 10 television programs/interviews were conducted during 2010/2011.
- 10,000 project information brochures were developed and distributed throughout northern and eastcentral Wisconsin during fall 2011.
- Project Principal Investigators hired 1 Natural Resources Research Scientist, 2 UW-Madison graduate students, and 9 field technicians for the 2010/11 deer trapping season.
- Five adult male deer were poached in northern Wisconsin during 2011.
- More than 200 Wisconsin citizens assisted with 2011 deer capture events.

- Mean dispersal distance by yearling deer in northern and eastcentral Wisconsin was 4.8 and 7.5 miles, respectively, but ranged from 1.5 to 20.0 miles.

- Across northern and eastcentral Wisconsin, 66% and 90%, respectively, of adult deer were non-migratory. Mean migration distance between seasonal ranges for migrant deer in the northern forest and eastern farmland regions was 3.8 miles and 2.7 miles, respectively.

- Maximum migration distances of adult female deer in northern and eastcentral Wisconsin was 9.0 miles and 4.5 miles, respectively.

- As of 31 December 2011, 19 adult males, 22 adult females, and 8 fawns continue to be monitored weekly for movement and survival status in northern Wisconsin.

- As of 31 December 2011, 21 adult males, 25 adult females, and 30 fawns continue to be monitored weekly for movement and survival status in eastcentral Wisconsin.

- Antibodies to epizootic hemorrhagic disease (EHD), bovine viral diarrhea virus (BVDV) 1 and 2, or *Leptospira* serovars *canicola* and *icterohaemorrhagiae* were not detected in blood samples from 143 deer.

- Few deer (1–3%) were exposed to eastern equine encephalitis (EEE), bluetongue (BLU), and *Leptospira* serovars *bratislava* and *grippotyphosa.*

- No male deer (0/44) were exposed to *Leptospira pomona* but 22.3% (21/91) of females were exposed (P = 0.003).

- Additionally, more females (33%) in northern WI were exposed to *Leptospira pomona* than females (11%) in eastcentral WI.

- One-hundred ten deer (71 females, 39 males) were sampled for ectoparasites. Parasites were not found on 70 (64%) deer.

- Female deer ticks (*Ixodes scapularis)* were present on 23% of deer sampled.

- Lice (*Tricholipeurus* sp.) were present on 17% of deer sampled.

Introduction:

White-tailed deer (*Odocoileus virginianus*) are the most widespread and abundant cervid in North America, occurring in all contiguous United States except Utah (Demarais et al. 2000, Rohm et al. 2007). In Wisconsin, deer are the favorite type of wildlife among hunters and non-hunters and are considered a major factor in the state's recreational economy (Wisconsin Department of Natural Resources 1998). Wisconsin's deer herd is managed by adjusting harvest quotas relative to overwinter population goals in established deer management units across the state. Broadly speaking, effective deer management strategies strive to balance ecological, social, cultural, and economic factors to maximize positive (while minimizing negative) impacts of deer on people and the environment. Understanding survival and cause-specific mortality factors is essential for accomplishing deer management objectives, particularly as it relates to population demographics and dynamics (Webb et al. 2007). Thus, a greater understanding of mortality factors throughout Wisconsin's deer management regions will provide game managers and decision makers with information critical for improving the state's current deer management program.

The Wisconsin Department of Natural Resources (WDNR) has relied on a mathematical model known as the Sex-Age-Kill (SAK) model to estimate white-tailed deer populations in deer management units across the state since the early 1960s. These estimates form the basis for management (hunting quotas) and have been a source of ongoing controversy with stakeholders (particularly hunters) for the past 50 years. A primary weakness of the model is that rigorous empirical estimates of mortality in adult male deer, which is a key variable in the SAK model, currently do not exist. The SAK model is a reconstruction procedure that estimates the pre-hunt population prior to the start of the annual hunting season, thus, population estimates are based on the number of deer available for harvest at the beginning of the hunting season. Thus, pre-season predation is accounted for in pre-hunt deer population estimates. An important assumption of the SAK method is that the aged sample of harvested bucks represents the population age structure. This assumption could be violated if hunters actively select against harvesting bucks with smaller antlers (primarily yearling bucks) or if vulnerability to harvest is higher in yearling than adult male deer. The age structure of harvested bucks in much of the state, particularly in the farmland regions, has changed markedly since the 1990s with the percentage of yearlings in the harvest declining from 80–85% in the 1980s to 50–60% in the mid 2000s. Increasing interest among hunters in harvesting large antlered bucks during the past 10–15 years has raised concerns about possible hunter selection bias against yearlings. There is uncertainty about how much changes in harvest age structure reflects changes in hunter selection and how much is due to changes in mortality rates.

To improve precision of SAK population estimates, an independent review of the SAK model by an external review panel recommended that the WDNR implement a long-term radiotelemetry study to obtain direct estimates of the buck (male deer) recovery rate (BRR) or its components (buck survival and cause-specific mortality rates) over multiple years and across varying habitat types (Millspaugh et al. 2007). However, this recommendation is confounded by the fact that radiotelemetry (the standard technique for estimating mortality rates) is likely biased with respect to hunting mortality (the most important mortality factor with respect to the SAK model) because hunters likely see and react to the presence of radiocollars in complex and unknown ways. Thus, while estimating cause-specific mortality of male deer is a priority for wildlife managers in Wisconsin, doing so with scientific rigor will require methods that are relatively resistant to biases associated with radiocollars, despite continued use of radiocollars for identifying non-hunting sources of mortality.

With increasing populations of large predators like black bears (*Ursus americanus*), wolves (*Canis lupus*), bobcats (*Felis rufus*), and coyotes (*Canis latrans*) in Wisconsin, stakeholders and wildlife managers are becoming increasingly concerned that predation on fawns may be limiting recruitment in white-tailed deer. Predation of white-tailed deer fawns has been studied extensively throughout North America, yet no information currently exists on the potential effects of predation on recruitment of deer in Wisconsin. High fecundity (i.e., 1.64–1.93 fawns/doe; McCaffery et al. 1998) combined with low observed FDRs across northern Wisconsin are suggestive of high fawn mortality rates shortly after the annual fawn birth pulse. Declining FDRs in recent years across the northern forest region may be indicative of high predation rates, poor nutritional condition of adult females, lower pregnancy rates than those documented during the mid-1980s, or severe weather (generally winter conditions). However, most fawn mortalities have occurred prior to Wisconsin's annual summer deer observation survey to estimate FDRs, thus, the majority of fawn mortality events should theoretically be accounted for in the observed FDR. It is possible that predators may be limiting fawn recruitment in northern Wisconsin, however, the potential for low pregnancy/fecundity rates and effects of winter weather and habitat conditions also may be important factors contributing to variation in fawn recruitment throughout the state. Information on basic concepts and principles of white-tailed deer ecology, particularly fawn survival and recruitment, has not previously been collected in Wisconsin. Thus, research evaluating the magnitude of cause-specific mortality and survival of white-tailed deer fawns would provide much needed information to game managers and decision makers tasked with developing more effective deer management strategies across Wisconsin.

Wildlife disease transmission is generally thought to be density dependent, based on the idea that rate of contact among individuals will be greater in dense populations. However, the effect that high deer densities have on transmission of diseases in free-ranging white-tailed deer in Wisconsin is unknown. Diseases circulating in deer also are unknown and disease transmission in high density deer herds could impact population dynamics.

The primary goal of our research is to estimate survival and cause-specific mortality rates of adult male and fawn white-tailed deer in the northern and eastern farmland deer management regions of Wisconsin. Quantifying the role of predation, winter severity, and potential habitat effects on fawn survival and subsequent recruitment in Wisconsin's northern forest and eastern farmland deer management regions are primary motivations for our research. Additionally, our research provides a unique opportunity to gather disease surveillance data. Current or unknown diseases circulating in Wisconsin deer populations could play a role in population dynamics, thereby influencing accuracy of population estimates.

Objectives:

1. Evaluation of efficacy and suitability of mark-recapture techniques for monitoring annual variation in buck recovery rates relative to time-dependent and time-independent factors.
2. Evaluation of radio telemetry as a technique for obtaining short-term direct estimates of buck recovery rates.
3. Estimation of hunter bias by comparing survival rates among radio telemetry, mark-recapture, and age structure analyses.
4. Evaluation of cost comparisons for age structure, telemetry, and mark-recapture techniques and feasibility of these techniques for routine population monitoring.
5. Estimate monthly, seasonal, and annual survival and cause-specific mortality rates of fawn and adult-female white-tailed deer.
6. Evaluate factors contributing to and/or provide updated information on white-tailed deer pregnancy and fawn recruitment rates in northern and eastcentral Wisconsin.
7. Quantify seroprevalence of diseases (particularly hemorrhagic disease viruses [HDV], parainfluenza 3 [PI3], infectious bovine rhinotracheitis [IBR], leptospirosis, eastern equine encephalitis virus [EEE], bovine diarrhea virus [BVDV], and ectoparasites) in deer populations in northern and eastcentral Wisconsin.
8. Compare disease exposure to concurrent estimates of deer density gathered by Wisconsin DNR.
9. Examine relationships between age, gender, body weight, land use, and study area on disease exposure status across northern and eastcentral Wisconsin.

Study Area:

Research will occur concurrently in two study areas that are selected to represent areas where habitat type and BRR are likely variable or uncertain. Broadly speaking, our study areas will occur within the Northern Forest and Eastern Farmland regions (Fig. 1) of Wisconsin.

Our northern forest study area encompasses an area of 3,557 mi^2 and includes portions of Sawyer, Price, and Rusk counties (Fig. 1). Approximately 34% of the land area is in public ownership (e.g., state and/or national forests) and much of the landscape (79.7%) consists of forested (e.g., northern hardwoods, aspen, balsam fir, pines, swamp conifers) or shrubland habitat. Primary land use in the area is forestry and topography is moderately rolling hills (Wisconsin DNR 2001). Average annual precipitation and seasonal snowfall is 33 inches and 58 inches, respectively (Wisconsin State Climatalogy Office 2012). Ambient temperatures average 12.6 °F in winter and 63 °F in summer (Wisconsin State Climatology Office 2012). Soils include stony glacial till, pitted outwash sands, and peat (Wisconsin DNR 2001). The road network across the area spans 5,697 miles, thus the estimated road density is approximately 1.60 linear mi/mi^2 of land area. Post-hunt deer densities range between 15 and 31 deer per square mile of deer range (Wisconsin DNR, unpublished data). Hunting pressure on opening day of the 9-day gun deer season ranges from 8 to 15 hunters per square mile of deer range (Wisconsin DNR, unpublished data). The northern study area has an abundant and widely distributed suite of large predators that are common to the area, including black bear, gray wolf, coyote, and bobcat.

Our eastern farmland study area encompasses an area of 2,318 mi^2 and includes portions of Shawano, Waupaca, and Outagamie counties (Fig. 1). Approximately 3.1% of the land area is in public ownership and slightly more than one-third (35.3%) of the landscape consists of forests and woodlots of central hardwoods, pines, and wetlands, or shrubland habitat. Severe winters and significant mortality of deer are infrequent and occur once every 10–15 years (Wisconsin DNR 2001). The primary land use throughout the area includes row crop agricultural and topography is dominated by gently rolling hills (Wisconsin DNR 2001). Average annual precipitation and seasonal snowfall is 32 inches and 46 inches, respectively (Wisconsin State Climatalogy Office 2012). Ambient temperatures average 17 °F in winter and 66.7 °F in summer (Wisconsin State Climatology Office 2012). Soils are predominantly loams. The road network across the area spans 5,978 miles, thus the estimated road density is approximately 2.6 linear mi/mi^2 of land area. Post-hunt deer densities range between 44 and 80 deer per square mile of deer range (Wisconsin DNR, unpublished data). Hunting pressure on opening day of the 9-day gun deer season ranges from 21 to 36 hunters per square mile of deer range (Wisconsin DNR, unpublished data). Relative to the northern study area, the composition and abundance of large predators throughout the eastern farmland region is reduced and comprised primarily of coyotes and bobcats.

RESULTS:

Winter Deer Capture

Northern Forest:

From 14 January–31 March 2011, project staff captured, radiocollared, and ear-tagged yearling (≥8 months) and adult (≥1.5 years) male and female white-tailed deer in northern (primarily Sawyer County) Wisconsin. We captured 204 individual deer (50 yearling males, 28 adult males, 29 yearling females, and 97 adult females), of which 195 were captured using standard ground trapping techniques and 9 were captured using helicopter net gunning. Additionally, we recaptured 161 deer. Thus, 204 captured deer were handled 365 times during winter 2011. Of 78 bucks captured, we fitted 70 (45 yearlings, 25 adults) with mortality-sensing radiocollars (Fig. 2); the remaining 8 individuals (5 yearlings, 3 adults) were fitted with small, uniquely-numbered metal ear tags (Fig. 3). Similarly, we captured, chemically immobilized, and radiocollared 40 adult females, of which 37 were examined for pregnancy using ultrasonagraphy and subsequently fitted with vaginal implant transmitters (VITs; Fig. 4). We detected pregnancy in 34 of 37

(92%) adult females; we were unable to identify fetuses in the 3 female deer due to complications with ultrasound equipment (cold temperatures) or significant intestinal blockage (e.g., fecal material) upon examination. We fitted the remaining 86 female deer captured with ear tags.

Eastern Farmland:
We captured 135 individual deer (55 males [33 yearling, 22 adult], 80 [26 yearling, 54 adult] females) in eastcentral (primarily Shawano and Outagamie counties) Wisconsin, of which 78 were captured using ground traps and 57 were captured using helicopter net gunning. Additionally, we recaptured 36 deer. Thus, 135 captured deer were handled 171 times during winter 2011. Of 55 males captured, we fitted 48 (28 yearlings, 20 adults) with radiocollars; the remaining 7 individuals (5 yearlings, 2 adults) were fitted with ear tags. Similarly, we captured, chemically immobilized, and radiocollared 46 adult females, of which all 46 were examined for pregnancy using ultrasonagraphy and subsequently fitted with VITs. Pregnancy was detected in 43 of 46 (94%) adult females; pregnancy could not be confirmed in the remaining 3 deer due to malfunction of ultrasound equipment (cold temperatures) or significant intestinal blockage (e.g., fecal material) upon examination. We fitted the remaining 34 female deer captured during winter 2011 with ear tags only.

We monitored rectal temperature, respiration, and heart rate of all captured adult females subject to ultrasonography and subsequent VIT tagging as soon as practical after immobilization and at 10-minute intervals thereafter until reversal drugs were administered. When practical, field personnel also recorded deer morphometrics and body weight (Table 1), assessed body condition, collected blood, hair, ectoparasite, and tooth samples from each captured adult female in both study areas. For yearling female deer captured, we collected deer morphometrics, blood, hair, and ectoparasite samples when practical. Because we were unable to implact VIT tags in yearling females (e.g., birth canal too small to insert VIT applicator), we did not chemically immoblize, perform ultrasonography, record body weight, VIT tag, or extract teeth from any individuals of this sex or age class. We field estimated body weight and age using molariform wear and replacement patterns (Severinghaus 1949) for all captured yearling females. Similarly, we did not chemically immobilize any male deer for handling and data collection procedures, thus we did not extract lower incisors for aging. Rather, age of each captured male deer was estimated into broad age classes (e.g,, fawn, yearling, adult) by examining wear and replacement of molariform teeth. When practical, we field estimated body weight, collected morphometric data, blood, hair, and ectoparasite samples from captured male deer. Mean pooled body weight for adult male and female deer in northern and eastcentral Wisconsin was 149.5 ± 29.3 and 129.1 ± 18.5 lbs, respectively. Similarly, mean pooled body weight for yearling male and female deer was 77.4 ± 26.5 and 64.2 ± 17.4 lbs, respectively (Table 1).

<u>Fawn Capture</u>
During mid-May to mid-June 2011, project staff captured, radiocollared, ear-tagged, and ear-tattooed deer fawns (Fig. 5) in northern and eastcentral Wisconsin. We located fawns using opportunistic ground searches, in which crew members were arranged in an evenly spaced linear format and high quality fawning habitat subsequently searched systematically for bedded fawns. Additionally, crew members conducted systematic searches for fawns from vaginal implant transmitter (VIT) tagged adult females.

Vaginal implant transmitter searches were conducted to locate fawns of 46 implanted pregnant females in eastcentral Wisconsin. Of 46 VIT-tagged females, 10 VITs malfunctioned so were not included in subsequent fawn searches. Birth sites of 15 of 36 VIT tagged females were searched for fawns. Eleven of 15 VIT searches resulted in the location of at least 1 fawn, of which 13 individuals were radiocollared, including 2 sets of twins. Because of high search efficiency during opportunistic ground searches, the capture of fawns from the remaining 21 VIT tagged females was unnecessary and subsequent VIT searches to locate fawns were abandoned. Although the percentage of fawn deer captured from VIT searches was relatively low (42%), our capture efficiency (75%) was higher than similar research using this technology (e.g., 66%; Carstensen et al. 2009), possibly as a result of comparatively large search crews, ability to efficiently search small parcels of land, and high deer densities across the eastern farmland study site.

VIT searches also were conducted to find fawns of 37 implanted pregnant females across northern Wisconsin, of which 23 VITs were expelled and accessible during late May. Of 14 remaining VITs, 2 were not expelled by female deer and 12 were located in inaccessible (remote) locations, thus were not included in subsequent fawn searching efforts. Eleven of 23 (48%) VIT searches resulted in the location of at least 1 fawn, of which all 11 animals were radiocollared. Percentage of fawn deer captured from VIT searches was lower than similar research using this technology and may have been affected by relatively small search crews and dense vegetation at presumed birth sites.

We captured 68 (13 VIT searches, 55 opportunistic searches) fawns from 14 May–4 June 2011 (Fig. 6) in the eastcentral study site, of which 48 (26 males, 22 females) were fitted with expandable radiocollars (model 4210, Advanced Telemtry Systems Inc., Isanti, MN, USA) and 20 fawns (10 males, 10 females) were ear-tagged. Similarly, we captured 36 fawns across the northern forest region from 17 May – 17 June 2011, of which 30 (17 males, 13 females) were radiocollared and 6 (3 males, 3 females) were ear-tagged. For each fawn captured, personnel recorded basic morphometric data (e.g., body weight [kg], hoof growth measurements [mm]), evaluated condition of the umbilicus, noted fawn behavior, identified sex, recorded age at capture (days), and ear-tattooed/tagged each animal with unique identification numbers at the time of capture. Additionally, we characterized fawn bed site locations and surrounding vegetation, recorded information on presence of dam and/or additional deer, dam behavior, distance to water, distance to nearest habitat edge, animal handling time, and hoof characteristics for each captured fawn. Temporal range of fawn parturition appeared similar between northern and eastcentral Wisconsin, peaking in late May with 90 of 104 (87%) fawns being captured on or before 1 June 2011 (Fig. 6). Mean pooled body weight of all male ($n = 56$) and female ($n = 48$) fawns was 11.0 ± 3.1 lbs and 9.7 ± 2.4 lbs, respectively. Similarly, mean age of male and female fawns when captured was 2.9 ± 2.4 days and 2.1 ± 1.6 days, respectively. New hoof growth measurements for male and female fawns was 0.05 ± 0.02 inches and 0.05 ± 0.02 inches, respectively.

Blood and ectoparasite sampling

We attempted to collect blood samples opportunistically from deer of all sex (male, female) and age (fawn, yearling, adult) classes via jugular venipuncture, though decisions were sometimes made during animal handling and processing events to terminate efforts to obtain samples due to the inability to locate the jugular vein in a timely manner, long animal handling and processing times, elevated animal stress level or body temperatures, or excessive animal activity under physical restraint. Thus, blood samples were not obtained from every deer we captured and handled. We separated serum from cells via centrifugation, and subsequently sent samples to the Minnesota Veterinary Diagnostic Laboratory for testing. We tested serum for antibody against *Leptospira interrogans* using microscopic agglutination, against BVDV and IBR using serum neutralization, against EEE using microtiter neutralization, against PI 3 using hemagglutination inhibition, and against HD viruses using agar immunodiffusion (Ingebrigtsen et al. 1986, Tate et al. 2005, Wolf et al. 2008). All samples testing positive for HD antibody via agar immunodiffusion were tested with virus neutralization to identify serotype of HD virus involved (Eaton 1996). Blood from adult females captured during winter was collected to estimate pregnancy rates using pregnancy-specific protein-B at a commercial lab (BioTracking, Moscow, Idaho 83843, USA); preliminary results are not yet available. Pregnancy assessment from blood followed guidelines established by DelGiudice et al. (2007). Ectoparasites were recovered from all immobilized deer and opportunistically from non-immobilized deer of all sex and age classes using methods outlined by Demarais et al. (1987). We initially searched for ectoparasites and obvious hair loss on external surfaces of the deer. Deer were searched for ectoparasites on two locations on the body: 1) the ears on the inside and outside distally from the lower notch, and 2) an index area (3.1 in × 3.1 in area on back by base of tail). We placed all ectoparasite samples collected in 50% ethanol until identified at the University of Wisconsin-Stevens Point. We used samples contained in the Stephen J. Taft Parasitology collection as reference.

Adult Deer Mortality

Northern Forest:

Fifty-nine radiocollared deer (42 males, 17 females) mortalities occurred through 31 December 2011; primary mortality sources included hunter harvest and predation (Table 2). Excluding capture-related and censored deer, predation accounted for 14 of 50 (28%) mortality events; wolves and bobcats were primary predators of yearling male deer (Table 3). Additionally, 9 mortalities occurred in traps or during capture operations prior to handling, in which deer broke necks or sustained physical injuries that subsequently resulted in euthanasia; these animals died prior to radiocollaring so were not included in Table 3. Several measures were implemented immediately to reduce capture mortality, including modifying netted cage traps to provide increased safety to captured animals. Following trap modifications, capture-mortality rates were reduced from ~8% to 3%. Radio contact with 7 additional yearling male deer was lost due to slipped or kicked collars, and complications or malfunctioning of radiocollars; these individuals will be censored from future analyses. Further modifications to deer trap and expandable buck radiocollar designs have been developed and will be implemented during future capture operations. There are 19 adult males and 22 adult females being monitored as of 31 December 2011, representing 50% and 59% male and female survival, respectively, through 9 months post-capture.

Eastern Farmland:

Forty-seven radiocollared deer (28 males, 19 females) mortalities occurred through 31 December 2011; primary mortality sources included hunter harvest, vehicle collisions, and capture-related deaths (Table 4). Six additional capture-related mortalities occurred in traps or during helicopter capture operations prior to handling, in which deer broke necks or sustained physical injuries that subsequently resulted in euthanasia; these animals died prior to radiocollaring so were not included in Table 4. Several measures were implemented immediately to reduce capture mortality, including modifying netted cage traps to provide increased safety to captured animals. Due to increasing public concern about capture-related deaths, helicopter net gun captures will be suspended during 2012 to further minimize capture-related mortality events. We documented no mortality due to predation in adult or yearling deer. Radio contact with 3 additional deer (1 male, 2 females; Table 3) was lost due to slipped or improperly functioning radiocollars, thus these individuals will be censored from future analyses. Modified expandable buck collars will be fitted on all male deer during future capture seasons. There are 21 adult males and 25 adult females being monitored as of 31 December 2011, representing 51% and 73% male and female survival, respectively, through 9 months post-capture.

We emphasize that our findings are both preliminary and limited to a single year of field data. Therefore, the tendency to draw conclusions or make meaningful inferences prior to the collection and comprehensive analyses of the full data set is not recommended. In year 1 of the buck mortality study, 19 of 38 (50%) adult bucks in the northern forest study area and 21 of 41 (51%) adult bucks in the eastcentral study area survived from one winter to the next, which is substantially lower than the model-derived estimates of the BRR across northern (70%) and eastcentral (80%) Wisconsin. Despite differences between field and model-derived estimates, our field estimates of BRR are within the range of annual buck survival rates (53-90%) and comparable to the average annual survival rate (60%) reported across the Midwest during the past 20 years (Nelson and Mech 1986, Fuller 1990, Nixon et al. 1991, Nixon et al. 1994, Van Deelen et al. 1997, Hansen and Beringer 2003). The ability to detect whether changes in harvest age structure reflects potential hunter selection biases are currently unknown and will require a more in-depth analysis of our data to better understand its effect on buck harvest rates, particularly yearling bucks. Despite uncertainty, preliminary results indicate that 18 of 40 (45%) total bucks harvested across our two study areas were ≤1.5 years of age.

Fawn Mortality

Northern Forest:

Twenty-two radiocollared fawn (13 males, 9 females) mortalities have occurred through 15 December 2011 (Table 5); this represents 73% of the 30 radiocollared fawns. Sources of mortality include starvation, hunter harvest, unknown causes of death, and predation (Table 5). Most (86%) fawn mortalities occurred from late-May through late-June (Fig. 6) and were attributed to predation (Fig. 7, Table 6). Incidents of starvation were associated with a set of twin fawns whose mother (also a radiocollared animal) was killed by a vehicle. Consequently, a bobcat killed both fawns, though starvation was identified as the ultimate cause of death since they would have died had the bobcat not killed them first. There are 8 fawns being monitored weekly for mortality as of 31 December 2011, representing 27% fawn survival through 7 months post-capture.

Eastern Farmland:

Eighteen radiocollared fawn (11 males, 7 females) mortalities have occurred through 31 December 2011 (Table 7); this represents 35% of the 48 radiocollared fawns. Eleven of 17 (65%) fawn mortalities occurred during the first month of life (e.g.. prior to 27 June 2011); remaining deaths occurred during July (n = 2), August (n = 2), and the November gun deer season (n = 2; Fig. 6). Predation accounted for 6 of 18 (33%) deaths (Table 8; Fig. 7). Additional sources of fawn mortality included abandonment, vehicle collision, harvest, unrecovered harvest, and an unknown cause of death (Table 6). Incidents of fawn abandonment were likely not caused by researcher handling, as personnel strived to minimize human scent transfer and time handling fawns. There are 30 fawns being monitored weekly for mortality as of 31 December 2011 representing 63% fawn survival through 7 months post-capture.

We emphasize again that our findings are both preliminary and limited to a single year of field data, thus the tendency to draw conclusions based on these data should be interpreted with caution. In year 1, we documented relatively high pregnancy rates in northern (92%) and eastcentral (93.5%) Wisconsin, suggesting that pregnancy rates have not changed since the mid-1980s across Wisconsin. Thus, low observed FDRs in the northern forest study area do not appear to be associated with low productivity in local deer populations. Interestingly, mean body mass of fawns in the northern forest (9.30 lbs ± 2.49 lbs) was significantly (t_{97} = 2.92, P = 0.004) lower than mean body mass of fawns captured in the eastcentral study area (11.00 lbs ± 2.91 lbs). Whether differences in fawn body mass (and thus reduced fitness) between our study areas may have predisposed northern fawns to higher rates of mortality (e.g., predation) than eastern fawns remains unknown. Though speculative, it is possible that declining FDRs in recent years across northern Wisconsin may be influenced in part by relatively high fawn mortality rates (73%) primarily due to predation. Our field estimates of fawn survival (27% and 62%) are comparable to the range of survival rates (28–76%) documented elsewhere across the United States (Huegel et al. 1985, Decker et al. 1992, Ballard et al. 1999, Vreeland et al. 2004, Saalfeld and Ditchkoff 2006, Rohm et al. 2007, Piccolo et al. 2010), though our field estimate for the northern forest region is on the low end of this range. Despite relatively low fawn survival in our northern forest study area, deer populations are typically less sensitive to fawn mortality than adult female mortality. Whether our observed fawn survival rates are low enough to reduce population growth (particularly in the northern forest region) remains unknown at this time. A more in-depth analysis of our data will be required to identify factors potentially influencing recruitment of deer across Wisconsin.

Blood samples

We collected 143 blood samples for analysis. We did not receive enough serum from every deer to run every test, so we prioritized antibody testing as follows:

1. Leptospirosis serovars
2. Bovine Viral Diarrhea Virus 1 and 2 (BVD 1 and 2)
3. Eastern Equine Encephalitis (EEE)
4. Epizootic hemorrhagic disease and Bluetongue (EHD and BLU)

5. Parainfluenza 3 (PI3)
6. Infectious Bovine Rhinotracheitis virus (IBR)

Deer were not exposed to EHD, BVD 1 and 2, or *Leptospira* serovars *canicola* and *icterohaemorrhagiae*. A limited number of deer were exposed to EEE, BLU, and *Leptospira* serovars *bratislava* and *grippotyphosa* (Table 9).

Preliminary results indicate that a substantial number of deer were exposed to *Leptospira* serovar *pomona*, PI3, and IBR. Overall, ten of 137 (7.3%) deer were exposed to IBR but gender differences were not significant (1/44 = 2.3% males and 9/93 = 9.7% females, $P = 0.18$). For PI3, 39 of 139 (28.3%) deer were exposed but site (24/74 = 32.4% in eastcentral WI and 17/64 = 26.5% in northern WI, $P = 0.60$) and gender (12/44 = 27% males and 27/94 = 29% females, $P = 1$) differences were not significant. No male deer (0/44) were exposed to *Leptospira pomona* but 22.3% (21/91) of females were exposed ($P = 0.003$). Additionally, more females in northern WI (16/49 = 32.6%) were exposed to *Leptospira pomona* than females in eastcentral WI (5/45 = 11.1%) but the Fisher's exact test was not significant ($P = 0.053$).

<u>Parasites</u>
We sampled a total of 110 white-tailed deer for ectoparasites (71 females, 39 males). We did not identify hair loss or skin lesions on deer captured. We sampled 60 deer from northern WI and 50 deer from eastcentral WI, and parasites were not found on 70 (63.6%) deer. *Damalinia* sp. were not identified and parasites were not found at the base of the tail.

Female deer ticks (*Ixodes scapularis)* were present on 22.7% of white-tailed deer sampled. Prevalence of *Ixodes scapularis* did not differ with gender ($P = 0.81$) or site ($P = 0.17$). Average intensity (number of parasites per host) of ticks on white-tailed deer sampled was 0.65 ticks per deer. Intensity of *Ixodes scapularis* did not differ with gender (males {0.79 ticks per deer}, females {0.58 ticks per deer}, $t = 2.01$, P = 0.70) or site (northern WI {0.67 ticks per deer}, eastcentral WI {0.64 ticks per deer}, $t = 1.99$, P = 0.95).

Lice (*Tricholipeurus* sp.) were present on 17.3% of white-tailed deer sampled. Prevalence (e.g., frequency of occurrence of disease within a group at a specific point in time; Wobeser 1994) of *Tricholipeurus* sp. did not differ with gender ($P = 0.29$) or site ($P = 0.46$). Average intensity of lice on white-tailed deer was 0.74 lice per deer. Intensity of *Tricholipeurus* sp. did not differ with gender (males {0.54 lice per deer}, females {0.85 lice per deer}, $t = 1.98$, P = 0.58) or site (northern WI {1.18 lice per deer}, eastcentral WI {0.20 lice per deer}, $t = 2.0$, $P = 0.10$).

We found no significant difference in ectoparasites by gender or site, potentially because nearly 64% of the deer sampled did not have parasites. We sampled fewer deer than several previous studies (Samuel and Trainer 1971, Demarais et al. 1987, Hribar et al. 1986) where higher intensities and prevalences were documented. Wisconsin deer had 22.7% lower lice prevalence than deer sampled in Tennessee (Hribar et al. 1986). Deer sampled in South Texas had 20.7% higher lice prevalence than deer sampled in Wisconsin (Samuel and Trainer 1971). Additionally, previous studies found that intensity and prevalence of lice and ticks on white-tailed deer did not differ with gender (Samuel and Trainer 1971, Demarais et al. 1987, Hribar et al. 1986). We expected that male deer would host greater numbers of lice than females because males come in close contact with greater numbers of conspecifics, but we did not detect a difference in intensity by gender. We expected deer from the northern forest study area to have higher intensities of ticks since habitat in northern Wisconsin is more forested than the eastern farmland study area (Durden and Keirans 1996), however, we did not detect any difference statistically. Perhaps deer in Wisconsin had few lice because they do not come in contact with other deer as often as deer from Mississippi, Tennessee and South Texas. In addition, Wisconsin's white-tailed deer population could be more sparsely populated when compared to deer populations in the southern United States (Samuel and Trainer 1971, Demarais et al. 1987, Hribar et al. 1986), and intensity of lice is influenced by frequency of physical contact encounters by deer (Nelson et al. 1977, Durden 1983). It is possible that deer are not concentrated to a large degree in our study areas. These findings are preliminary and we hope to identify relationships among parasite load and site, gender, and age with future data analyses.

Adult and Fawn Deer Telemetry

Movement and survival status of radiocollared adult and fawn deer was monitored 1–7 times weekly using aerial or ground telemetry. We have obtained 25–30 location estimates from all adult deer (48 males, 54 females) currently alive. Radiocollared fawns were monitored for mortality daily through August and are currently being monitored for survival and movement status weekly. Monitoring of all radiocollared deer will continue until death, collars drop off (as is the case with fawns), or until loss of contact with radiocollars occurs. Mortality events are investigated upon receiving a mortality signal to estimate survival and cause-specific mortality factors.

Adult and Yearling Deer Seasonal Movements

From April through July 2011, we monitored movements of 58 yearling and 41 adult male deer on two study areas (northern forest and eastern farmland) in Wisconsin. Across northern and eastcentral Wisconsin, 35% (n = 11) and 22% (n = 6) of yearlings, respectively, exhibited dispersal (e.g., emigration from natal home ranges to subsequent adult home ranges) movements. Mean dispersal distance in the northern forest study area was 4.8 miles but ranged from 1.5 to 12 miles. Similarly, mean dispersal distance in the eastern farmland study area was 7.5 miles but ranged from 1 to 20 miles. We documented seasonal movements by 27% (n = 4) and 15% (n = 2) of adult males in the northern forest and eastern farmland study areas, respectively; maximum distances traveled were 5.4 miles (northern forest) and 6.0 miles (eastern farmland).

From April through July 2011, we monitored movements of 63 adult (≥1.5 years) female deer in both study areas. In our northern forest and eastcentral study areas, 66% and 90%, respectively, of female deer were nonmigratory. Mean migration distance between seasonal ranges for migrant deer in the northern forest (n = 11) and eastern farmland (n = 3) study areas was 3.8 miles and 2.7 miles, respectively. Maximum migration distances of adult female deer in the northern forest and eastcentral farmland was 9.0 miles and 4.5 miles, respectively.

Vegetation Surveys

We conducted surveys quantifying vegetation structure, composition, and density at paired fawn (bed site + random site) capture locations in the eastcentral and northern forest study sites, respectively, during June 2011. We attempted to measure vegetation characteristics at 1–3 fawn bed sites (e.g., original capture location and 1–2 subsequent bed site locations obtained within 3-weeks post-capture) for each radiocollared fawn. Due to growth of vegetation, difficulty locating fawns, and time constraints imposed on crew members, we were unable to obtain subsequent locations on every radiocollared fawn in both study areas. Consequently, we conducted vegetation surveys at 176 and 51 paired in the eastcentral and northern forest study sites, respectively. Vegetation data will be used to test whether fawn capture locations differ in structural vegetation characteristics compared to random locations. Additionally, we will assess whether selection of fawning sites differs among study areas. Completion of vegetation survey data entry is anticipated by April 2012; preliminary data analyses are anticipated during summer 2012.

Public Outreach

We developed a tri-fold project brochure for public distribution across the northern forest and eastcentral farmland study areas. We distributed 10,000 copies of this brochure throughout our study areas prior to the start of the 2011 deer hunting season; our goal was to provide hunters with project background information, study objectives and field techniques, contact information for project staff, and harvest reporting instructions for radiocollared and ear-tagged deer. We developed and launched a project website (http://dnr.wi.gov/org/es/science/wildlife/deer/) that has been online since April 2010, including a volunteer sign up form, which includes information requests for individuals interested in becoming involved with Wisconsin's deer research program. Additionally, the website provides opportunities for individuals to subscribe to receive periodic deer research updates.

Numerous outreach efforts were conducted for the projects, including:

Project meetings with area sportsmen groups:

- Whitetails Unlimited
- Safari Club International
- Union Sportsmen's Alliance
- Quality Deer Management Association
- Wisconsin Conservation Congress Big Game Committee

Presentations:

1) Jacques, C. N., T. R. Van Deelen, C. A. Priest, and M. Preisler. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Sheboygan County Conservation Association, Sheboygan, Wisconsin. 12 attendees.

2) Jacques, C. N., T. R. Van Deelen, A. S. Norton, M. A. Watt, C. A. Priest, C. H. Warbington, and M. Preisler. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Buck Fever Night hosted by the Manitowoc County Hunter Safety Instructors, Manitowoc, Wisconsin. 180 attendees.

3) Jacques, C. N., T. R. Van Deelen, and A. S. Norton. 2011. Estimating survival and cause-specific mortality of male white-tailed deer in Wisconsin. Invited Presentation, Bureaus of Wildlife Management and Science Services Joint Annual Meeting, Madison, Wisconsin. 80 attendees.

4) Jacques, C. N., T. R. Van Deelen, and C. H. Warbington. 2011. Impact of predation, winter weather, and habitat on white-tailed deer fawn recruitment in Wisconsin. Invited Presentation, Bureaus of Wildlife Management and Science Services Joint Annual Meeting, Madison, Wisconsin. 80 attendees.

5) Jacques, C. N., M. A. Watt, A. S. Norton, and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to landowners and deer hunters of the community of Shawano, Wisconsin during a deer research landowner/volunteer appreciation day. 110 attendees.

6) Jacques, C. N., M. A. Watt, A. S. Norton, and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Whitetails Unlimited Donor Group, Marshfield, Wisconsin. 275 attendees.

7) Jacques, C. N., M. A. Watt, A. S. Norton, and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to landowners and deer hunters of the community of Winter, Wisconsin during a deer research landowner/volunteer appreciation day. 65 attendees.

8) Jacques, C. N., T. R. Van Deelen, M. A. Watt, and A. S. Norton. 2011. Estimating survival and cause-specific mortality of adult male white-tailed deer in Wisconsin: First year results. Poster Presentation, Wisconsin Annual Deer Fest, Oshkosh, Wisconsin.

9) Jacques, C. N., T. R. Van Deelen, M. A. Watt, A. S. Norton, and C. H. Warbington. 2011. Impact of predation, winter weather, and habitat on white-tailed deer fawn recruitment in Wisconsin: First year results. Poster Presentation, Wisconsin Annual Deer Fest, Oshkosh, Wisconsin.

10) Jacques, C. N., M. A. Watt, B. J. Dhuey, and T. R. Van Deelen. 2011. Investing in Wisconsin's Whitetails: Deer Research and Public Survey Updates. Wisconsin Annual Deer Fest, Oshkosh, Wisconsin.

11) Jacques, C. N., M. A. Watt, and T. R. Van Deelen. Investing in Wisconsin's Whitetails: Deer Research 2010–2015. Invited Presentation, Shawano County Optimist Club, Shawano, Wisconsin. 29 attendees.

12) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Navarino Nature Center Annual Executive Council Meeting, Shiocton, Wisconsin. 35 attendees.

13) Jacques, C. N., T. R. Van Deelen, and M. J. Riggle. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Wisconsin Conservation Congress Annual Meeting, Wausau, Wisconsin. 200 attendees.

14) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Shawano County Highway Department, Shawano, Wisconsin. 60 attendees.

15) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to the Sheboygan County Conservation Association, Sheboygan, Wisconsin. 95 attendees.

16) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to the Wisconsin Wildlife Federation, Steven's Point, Wisconsin. 30 attendees.

17) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to Clintonville Bow Hunters Club, Marion, Wisconsin. 60 attendees.

18) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to the Big Falls Bow Hunters Club, Marion, Wisconsin. 175 attendees.

19) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to Black Creek Quality Deer Management Association, Black Creek, Wisconsin. 50 attendees.

20) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to the Wisconsin Society of Science Teachers Conference, Wisconsin Dells, Wisconsin. 20 members.

21) Jacques, C. N., and T. R. Van Deelen. 2011. Investing in Wisconsin's whitetails:research 2010–2015. Invited Presentation, Wisconsin Department of Natural Resources Wildlife Management Statewide Annual Meeting, Appleton, Wisconsin. 300 attendees.

22) Jacques, C. N., and T. R. Van Deelen. 2010. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Appleton Optimist Club, Appleton, Wisconsin. 20 attendees.

23) Jacques, C. N., and T. R. Van Deelen. 2010. Investing in Wisconsin's Whitetails and Union Sportsmen's Alliance Boots on the Ground Program. Invited Presentation, Wisconsin Laborer's Union, Wisconsin Rapids, Wisconsin. 35 attendees.

24) Jacques, C. N., and T. R. Van Deelen. 2010. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, University of Wisconsin Stevens Point Student Chapter of The Wildlife Society, Stevens Point, Wisconsin. 95 attendees.

25) Jacques, C. N., and T. R. Van Deelen. 2010. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Wisconsin Department of Natural Resources Northern Wildlife Management Staff Annual Meeting, Hannibal, Wisconsin. 60 attendees.

26) Jacques, C. N., and T. R. Van Deelen 2010. Investing in Wisconsin's whitetails: research 2010–2015. 2nd Annual Living Wild Outdoors Festival, Appleton, Wisconsin.

27) Jacques, C. N., and T. R. Van Deelen. 2010. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to landowners and deer hunters from Winter, Wisconsin. 30 attendees.

28) Jacques, C. N., and T. R. Van Deelen. 2010. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented to Exeland Rod and Gun Club, Exeland, Wisconsin. 55 attendees.

29) Jacques, C. N., and T. R. Van Deelen. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented the Wisconsin Conservation Congress, Ladysmith, Wisconsin. 25 attendees.

30) Jacques, C. N., and T. R. Van Deelen. 2010. Investing in Wisconsin's whitetails: research 2010–2015. Invited Presentation, Presented Wisconsin Conservation Congress, Clintonville, Wisconsin. 21 attendees.

31) Jacques, C. N., and T. R. Van Deelen. 2010. Impacts of harvest, predation, winter weather, and habitat on survival and recruitment of white-tailed deer in Wisconsin. Invited Presentation, Wisconsin Department of Natural Resources Deer Research Oversight Team Meeting, Madison, Wisconsin. 25 attendees.

32) Jacques, C. N., and T. R. Van Deelen. 2010. Impacts of harvest, predation, winter weather, and habitat on survival and recruitment of white-tailed deer in Wisconsin. Invited Presentation, Wisconsin Chapters of the Safari Club International Meeting, Oshkosh, Wisconsin. 30 attendees.

Popular articles:

1) Wisconsin State Journal . 13 April 2010. "The Deer Hunters – What toll do wolves, bears and other predators take on deer herds?" *Contributing Writer*: Ron Seely

2) Wisconsin Outdoor News. 22 July 2010. "Wanted: Deer hunters to aid in research." http://outdoornews.com/wisconsin/news/article_cf85f732-9505-11df-8ae5-001cc4c002e0. html?mode=story. *Contributing Writer*: Lee Fahrney

3) Shawano Leader. 25 July 2010. "Meeting looks at deer research in works for Shawano, Waupaca counties." http://www.shawanoleader.com/ articles/2010/07/25/ news/news2.txt

4) The Monroe Times. 1 July 2010. "Volunteers needed for deer research effort." http://www.themonroetimes.com/main.asp?SectionID=6&SubSection ID=61&ArticleID=19329 &TM=9670.29. *Contributing Writer*: Lee Fahrney.

5) Wisconsin Department of Natural Resources. 14 March 2010. "Wisconsin to Study Predator Impacts on Deer." http://www.biggamehunt.net/news/wisconsin-study-predator-impacts-deer.

6) Appleton Post Crescent. 25 July 2010. "Wisconsin Department of Natural Resources plans $2 million in deer studies."

7) Midwest Hunting Online Hunting Show. July 2010. "Impacts of harvest and predation on survival and recruitment of white-tailed deer." http://www.midwestwhitetail.com/ gallery/84/ media/2332/wi107-herd-management.html.

8) The Outdoor Wire. 28 September 2010. "Union Sportsmen's Alliance Boots on Ground Conservation Program Provides Critical Manpower." http://www.theoutdoorwire.com/ story/1285634043s00ensea2ba.

9) Great Northern Outdoors. 21 January 2011. "Keep eye on sky for flying deer." http://www.greatnorthernoutdoors.net/wisconsin-deer-study. *Contributing Writer*: Dave Carlson.

10) Wisconsin Outdoor News. 24 January 2011. "WI DNR Researchers Studying Causes of Deer Predation." http://outdoornews.com/wisconsin /news/article_819da63c-27d1-11e0-884f-001cc4c002e0.html. *Contributing Writer*: Dan Hansen.

11) Wisconsin Wildlife Federation. 26 January 2011. "Deer Research Effort Volunteers Needed." http://www.wiwf.org/news/Wisconservation/ February11issue.pdf.

12) Milwaukee Journal Sentinel. 26 February 2011. "Deer projects will examine state's herd." http://www.jsonline.com/sports/ outdoors/ 116990233.html. *Contributing Writer*: Paul Smith.

13) Northland Adventures. 25 February 2011. "At last off the ground." http://www.wqow.com/Global/category.asp?C=183584 &nav=menu1364_8_1. *Contributing Writer*: Dave Carlson.

14) Barron News-Shield. 4 March 2011. "Researchers wrestling with whitetail population study. Barron News-Shield, 4 March 2011. *Contributing Writer*: Luke Klink.

15) Central Wisconsin Sports. 12 April 2011. "Outdoors Feature: Tackling the state's whitetail research project. . http://www.centralwisconsin sports.net/2011/03/outdoors-feature-tackling-the-wisconsin-whitetail-deer-herd-with-research/. *Contributing Writer*: Scott Stankowski.

16) Wisconsin Department of Natural Resources. 10 May 2011. "Locating new fawns is next step in deer research project; volunteers needed." http://dnr.wi.gov/news/ DNRNews_Lookup.asp?id=274#art4

17) Central Wisconsin Sports. 29 May 2011. "Outdoors Feature: Fawns Are Easier to Tackle: Deer Research Project Phase II." http://www.centralwisconsinsports.net/2011/05/fawns-are-easier-to-tackle-deer-research-phase-ii/. *Contributing Writer*: Scott Stankowski.

18) Milwaukee Journal Sentinel. 28 May 2011. "Study tracks fawn survival and mortality." http://www.jsonline.com/sports/outdoors/12278413.html. *Contributing Writer*: Paul Smith.

19) Wisconsin Outdoor News 18(12):1,6. 2011. "Fawn capture and tagging study continues." *Contributing Writer*: Dan Hansen.

20) The Bee. 7 July 2011. "Researchers learning impact of predators on deer herd." *Contributing Writer*: Eric Knudson.

21) Milwaukee Journal Sentinel. 11 September 2011. "Two study areas in the state produce varying deer data." http://www.jsonline. com/ sports/ outdoors/129596158.html. *Contributing Writer*: Paul Smith.

22) Milwaukee Journal Sentinel. 11 September 2011. "Ear-tagged deer are legal game." http://www.jsonline.com/ sports/outdoors/129596163.html. *Contributing Writer*: Paul Smith.

Radio Shows:

1) Wisconsin Public Radio, WXPR, FM 91.7. Impacts of harvest, predation, winter weather, and habitat on survival and recruitment of white-tailed deer in Wisconsin.

2) Wisconsin Radio Network, WIBA, AM 1310. Impacts of harvest, predation, winter weather, and habitat on survival and recruitment of white-tailed deer in Wisconsin.

3) Wisconsin Public Radio. Impacts of harvest and predation on survival and recruitment of white-tailed deer.

4) WHBY, AM 1150. Impacts of harvest and predation on survival and recruitment of white-tailed deer.

5) WTCH, AM 960. DNR to study buck mortality in Shawano County. .

Numerous other articles (e.g., newspapers and web pages) were published and distributed through the Associated Press.

Television programs and interviews:

1) In Wisconsin/Wisconsin Public Television | November 25, 2010 – Deer Research (http://wpt2.org/npa/IW908.CFM).

2) In Wisconsin/Wisconsin Public Television | November 25, 2010 – The Plan to radio collar fawns (http://video.wpt2.org/video/1662427520).

3) In Wisconsin/Wisconsin Public Television | November 25, 2010 – Why use both collars and ear tags (http://video.wpt2.org/video/1662427507).

4) Deer herd concerns - DNR plans to track deer lives, deaths. WLUK-TV FOX 11 News. http://www.fox11online.com/dpp/news/dnr-holding- deer-study-meeting-tonight.

5) Union Sportsman's Alliance Boots on Ground deer trap project. WFRV-TV Channel 5 News.

6) In Wisconsin/Wisconsin Public Television | April 7, 2011 – Deer Research Update. http://video.wpt2.org/video/1872444532/.

7) DNR: Don't Look for Collars or Tags When Hunting Deer. WBAY TV Channel 2 News, 16 September 2011. http://www.wbay.com/story/15482897/2011/09/16/dnr-dont-look-for-collars-or-tags-when-hunting-deer.

8) DNR: Shoot Deer Even with Radiocollars. WBAY TV Channel 2 News, 16 September 2011. http://www.wbay.com/category/169373/video-landing-page.

9) DNR asks hunters to help if they get deer with tags and collars. WEAU-TV 13, 18 October 2011. http://www.weau.com/news/headlines/ DNR_asks_hunters__to_help_if_they__get_deer_with_tags_and_collars_132107938.html?ref=938.

10) Deer Hunt 2011 Program. Dan Smalls Outdoors, http://www.youtube.com/watch?v=PG_U8aXGASQ.

To improve communication and transparency of our research results, department staff will work collaboratively and cooperatively with Wisconsin DNR website coordinator Brent Alderman to improve our existing website design to more effectively communicate results and management implications of our research projects to a broader public. The information also will also be used to guide our future outreach efforts, as well as encourage further public cooperation and participation with the project.

Protocols, Manuals, and Datasheets

The following field protocols have been created:

- Adult deer capture and radiocollaring/ear tagging
- Fawn capture and radiocollaring/ear tagging/ear tattooing
- Adult deer capture priorities
- Ultrasound instructions
- Field mortality investigations
- Vegetation/habitat data collection
- Instructions for netting Clover (e.g., netted cage) traps
- Marked deer reporting instructions
- Study area emergency action plans
- Lyme disease action plan
- New employee safety training
- Basic safety training
- Field crew orientation for new research technicians
- UW-Madison animal care and use protocol (approved 5 Aug 2010 and amended on 8 July 2011)
- Collection of brisket fat measurements
- Collection of deer morphometric (neck measurements) data

The following datasheets have been created:

- Deer fawn capture
- Adult deer capture
- Vegetation survey
- Helicopter capture
- Daily deer capture

- Deer fate reporting
- Deer radiotelemetry (biangulations)
- Deer mortality
- Controlled substance log
- Deer body fat measurements
- Deer neck measurements

Project Field Crew Selection and Hires

Project principal investigators Chris Jacques and Tim Van Deelen selected and hired a DNR Natural Resources Research Scientist and 2 Graduate Research Assistants (Andrew Norton and Camille Warbington) for the buck mortality and fawn recruitment projects. Additionally, project principal investigators posted a position description for independent deer research contractors on the Texas A&M Wildlife and Fisheries Sciences departmental website. We received and evaluated 69 applications and hired 9 individuals for the 2011 deer trapping season, including:

Erin Adams
Nathan Bieber
Ryan DeVore
Chelsey Faller
Talesha Karish
Gretchen Oleson
Brittany Peterson
Christine Priest
Michael Preisler

Numerous members of the public (> 200) also participated in winter (adult) and spring (fawn) deer trapping efforts throughout both study areas. Graduate Research Assistants have begun to select graduate committees at the University of Wisconsin-Madison as well as prepare their research proposals.

Planning for 2011–12 Trapping Season:

Deer Trapping

Modifications to improve our netted-cage trap design to reduce trap-induced deer mortality are currently being implemented. Specifically, we tightened the netting around the steel frame to reduce the likelihood of physical injuries (and death) to captured deer. Additionally, we have modified our expandable buck radiocollar design to ensure proper neck fit, which will subsequently reduce the likelihood of entanglement of legs or other unanticipated complications related to improper collar fit. With the suspension of helicopter capture operations during winter 2012, we will need to increase the duration and intensity of ground trapping efforts during winter 2012. We initiated deer capture efforts on private properties in both study areas during mid-December (e.g., immediately following the statewide antlerless gun deer season) to increase the likelihood of capturing adequate numbers of deer of all sex and age classes, particularly adult males. Additional field personnel will be hired during winter 2012 to increase our ground trapping efficiency and minimize time that deer spend in traps. Additionally, we will increase the duration and number of drop nets used for deer capture during 2012 to increase selectivity potential for targeting adult male deer. Depending on ground trapping success during winter 2012, it is possible helicopter capture may be needed in the future.

Equipment preparation/inventory

Field crew members conducted an inventory of field equipment and completing the netting of 50 additional netted cage traps prior to the start of the 2011–12 trapping season (e.g., 12 December 2011).

Completion of ≥30 of the 50 traps occurred prior to 12 December 2011; remaining traps will be completed during early 2012. Construction of 100 modified triggers for netted cage traps also occurred prior to the start of the 2012 winter trapping season; modifications will reduce the number of unsuccessful capture events during 2012 and subsequent capture seasons. Crew members also are inspecting all trapping equipment to ensure that all field gear is functioning properly.

Coordinating deer trapping schedule

Field crew coordinators identified private landowners throughout our study areas who allowed trapping on their properties during December 2011, and subsequently established bait sites on these properties during early December. To date, we have secured permission (and have established bait sites) on 8–10 properties throughout both study areas and positioned traps (e.g., box and/or netted-cage traps) and drop nets at bait site locations during the week of 5 December. Trapping activities were initiated in the east-central study site (Shawano area) on 12 December to maximize the likelihood of identifying and subsequently capturing adult bucks prior to antler drop. Preliminary trapping activities provided opportunities for new crew members to become proficient with deer trapping, handling, and data collection procedures prior to significant public involvement in deer trapping activities from trained volunteers (e.g., hunt clubs, scout groups, student groups, deer hunters, etc.). Following 8 January 2012 (e.g., last day of WI deer archery season), trapping activities transitioned to public properties, particularly in our northern forest study area.

Radiotelemetry

Deer captured and radiocollared during 2011 will continue to be monitored for survival and movement status throughout 2012 using ground-based and aerial telemetry techniques. All radiocollared deer will be monitored weekly until death or loss of contact with radiocollars occurs. Radio collaring and ear-tagging/mark recapture efforts will continue through winters 2013 and 2014, respectively. We will maintain 70 radiocollared male deer (35 yearlings, 35 adult bucks) using winter trapping to replace individuals lost to mortality or collar loss.

Protocols and Manuals

Creation and/or updating of research protocols, manuals and datasheets for the following:

- Capture/Trapping
- Immobilization and Handling
- Telemetry (ground and aerial)
- Ultrasound and Necropsy
- Vegetation/Habitat data collection
- Creation of Conduct/Expectation Manual for seasonal staff

2011 Project Field Crew Selection and Hires

Project principal investigators Chris Jacques and Tim Van Deelen have selected 12 natural resources research technicians and 2 field crew leaders as members of the 2011–12 field crew; all 14 crew members will be hired for 6 months (January–June 2012) as limited term employees for the Wisconsin DNR and their field activities directed by project PI Chris Jacques. Deer research staff members continue to solicit assistance from civilian volunteers; hundreds of WI citizens have expressed interest in assisting with deer capture events during winter 2011–12. University of Wisconsin-Madison Graduate Research Assistants are finalizing their graduate committees and research proposals, and will be scheduling their research seminars and/or qualifying oral examination during spring 2012. Project PIs will be training new crew members during early 2012 in Madison, WI.

Project Timeline

The buck mortality study is designed for five years (2010-11 through 2014-15) and across multiple study areas in order to better understand potential effects of temporal and spatial (e.g., habitat) variation on buck mortality. Quantifying effects of various time-dependent (e.g,. weather) and time-independent (e.g., habitat, deer density, hunter density, road density, parcel size, etc.) factors across multiple DMUs, particularly DMUs where the SAK model predicts poorly over time, may provide insight for improving accuracy and precision of deer population modeling in Wisconsin. Field work (e.g., deer trapping) is scheduled to occur through winter 2014.

The fawn recruitment study is designed for three years (2010–11 through 2012–13) and across multiple study areas in order to provide empirical estimates of potential impacts and relative magnitude of habitat, winter severity, and predator effects on fawn survival and subsequent recruitment in deer populations across forested and agricultural landscapes in Wisconsin. Field work will be completed following the 2012 fawn capture season (late May/early June 2012).

Detailed annual reports, final project reports, published manuscripts, and biweekly updates throughout the capture seasons will be produced during these studies. Results of this work will be provided to numerous stakeholders, including (but not limited to) external partners and collaborators, media, Wisconsin citizens, DNR staff, policy makers, and as presentations during scientific meetings and outreach efforts across Wisconsin over the duration of these projects.

Literature Cited:

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Table 1. Mean ($\bar{X}$) and standard deviation (SD) of captured adult (≥ 18 months) and yearling (8–10 months) male and female white-tailed deer morphometrics, northern and eastcentral Wisconsin, USA, January–March 2011. Blank cells represent no data.

	Sex and Age Class			
	ADM[a] (n = 18)	ADF[b] (n = 85)	YM[c] (n = 30)	YF[d] (n = 20)
Estimate	$\bar{X}$ ± SD	$\bar{X}$ ± SD	$\bar{X}$ ± SD	$\bar{X}$ ± SD
Body weight (lbs)	149.5 ± 29.3	129.2 ± 18.5	77.4 ± 26.5	64.2 ± 17.4
Chest girth (in)	38.5 ± 3.3	37.6 ± 4.7	30.8 ± 4.8	29.4 ± 4.6
Neck circumference 1 (in)[e]	15.6 ± 1.3	14.2 ± 1.3	12.5 ± 1.2	11.4 ± 1.5
Neck circumference 2 (in)[f]	19.3 ± 2.0	17.2 ± 2.0	15.4 ± 1.8	13.8 ± 2.1
Hind foot (in)	14.5 ± 1.0	13.8 ± 0.9	12.7 ± 1.0	12.0 ± 1.7
Rump fat (in)[g]		10.2 ± 3.1		

[a]Adult male deer

[b]Adult female deer

[c]Yearling male deer

[d]Yearling female deer

[e]Measured at top of neck ventral to the chin

[f] Measured at base of neck anterior to the front shoulders

[g]Measured approximately 20° off tail head from muscle layer to skin

Table 2. Cause-specific mortality of radiocollared adult (≥18 months) and yearling (8–10 months) male and female white-tailed deer, northern Wisconsin, USA, January–December 2011.

	Sex and Age Class		
Mortality cause	ADM[a] (*n* = 17)	ADF[b] (*n* = 17)	YM[c] (*n* = 25)
Harvest	7	4	9
Predation	2	3	9
Vehicle	2	2	1
Poaching	4	0	1
Capture-related[d]	2	3	1
Starvation	0	3	2
Unrecovered harvest[e]	0	0	1
Unknown	0	2	1

[a]ADM = Adult male deer

[b]ADF = Adult female deer

[c]YM = Yearling male deer

[d]Includes radiocollared deer that died of capture myopathy or physical injuries sustained during or within 2 weeks of capture events

[e] Suspected wounding loss due to hunting

Table 3. Radiocollared adult (≥18 months) and yearling (8–10 months) male (n = 11) and female (n = 3) white-tailed deer predation sources during, northern Wisconsin, USA, January–December 2011.

	Sex and Age Class		
Probable Predator	ADM[a]	ADF[b]	YM[c]
Wolf	0	0	4
Bear	0	1	0
Bobcat	0	1	2
Coyote	0	1	1
Unknown[d]	2	0	2

[a]Adult male deer

[b]Adult female deer

[c]Yearling male deer

[d]Insufficient evidence at death site to document probable predating species

Table 4. Cause-specific mortality of radiocollared adult (≥18 months) and yearling (8–10 months) male and female white-tailed deer, eastcentral Wisconsin, USA, January–December 2011.

Mortality cause	Sex and Age Class		
	ADM[a] (*n* = 12)	ADF[b] (*n* = 19)	YM[c] (*n* = 16)
Harvest	7	6	10
Vehicle	1	4	4
Capture-related[d]	1	7	1
Disease	0	1	0
Starvation	1	0	0
Unrecovered harvest[e]	2	1	1

[a]Adult male deer

[b]Adult female deer

[c]Yearling male deer

[d]Includes radiocollared deer that died of capture myopathy or physical injuries sustained during or within 2 weeks of capture events. All individuals will be censored from analyses

[e]Suspected wounding loss due to hunting

Table 5. Cause-specific mortality of radiocollared fawn male (n = 13) and female (n = 9) white-tailed deer, northern Wisconsin, USA, May–December 2011.

	Sex	
Mortality cause	Male	Female
Predation	7	7
Harvest	2	1
Starvation[a]	2	0
Unknown[b]	2	1

[a] Radiocollared adult female killed by vehicle and her fawns were killed by bobcat 2 and 3 days, respectively. Proximate cause of death of fawns was predation, though they would have died (e.g., ultimate mortality cause) of starvation had predation not occurred. Hence, deaths were classified as starvation.
[b]Insufficient evidence at death site to document probable cause of death in two animals.

Table 6. Radiocollared fawn male (n = 7) and female (n = 7) white-tailed deer predator sources, northern Wisconsin, USA, May–December 2011.

	Sex	
Mortality cause	Male	Female
Black bear	2	3
Bobcat	1	1
Coyote	1	0
Unknown canid[a]	2	0
Unknown[b]	1	3

[a]Insufficient evidence at death site to document specific predating canid species

[b]Insufficient evidence at death site to document probable predating species

Table 7. Cause-specific mortality of radiocollared male (*n* = 11) and female (*n* = 7) fawn white-tailed deer, eastcentral Wisconsin, USA, May–December 2011.

Mortality cause	Sex	
	Male	Female
Predation	4	2
Vehicle	2	1
Harvest	0	1
Starvation	5	1
Unknown	0	1
Unrecovered harvest[a]	0	1

[a]Wounding loss due to hunting

Table 8. Radiocollared fawn male (n = 4) and female (n = 2) white-tailed deer predator sources, eastcentral Wisconsin, USA, May–December 2011.

	Sex	
Mortality cause	Male	Female
Black bear	1	0
Coyote	2	2
Unknown[a]	1	0

[a]Insufficient evidence at death site to document probable predating species

Table 9. Exposure of white-tailed deer to hemorrhagic disease/bluetongue (BLU), eastern equine encephalitis (EEE), and letpospirosis viruses, Wisconsin, USA, January–March 2011.

Antibody test	Proportion exposed	Males exposed	Females exposed
EEE	4/138 = 2.7%	1/44 = 2.2%	3/94 = 3.1%
BLU	2/139 = 1.4%	Unknown	Unknown
Leptospira bratislava	2/140 = 1.4%	0/42	2/91 = 2.1%
Leptospira grippotyphosa	3/140 = 2.1%	0/43	3/93 = 3.2%

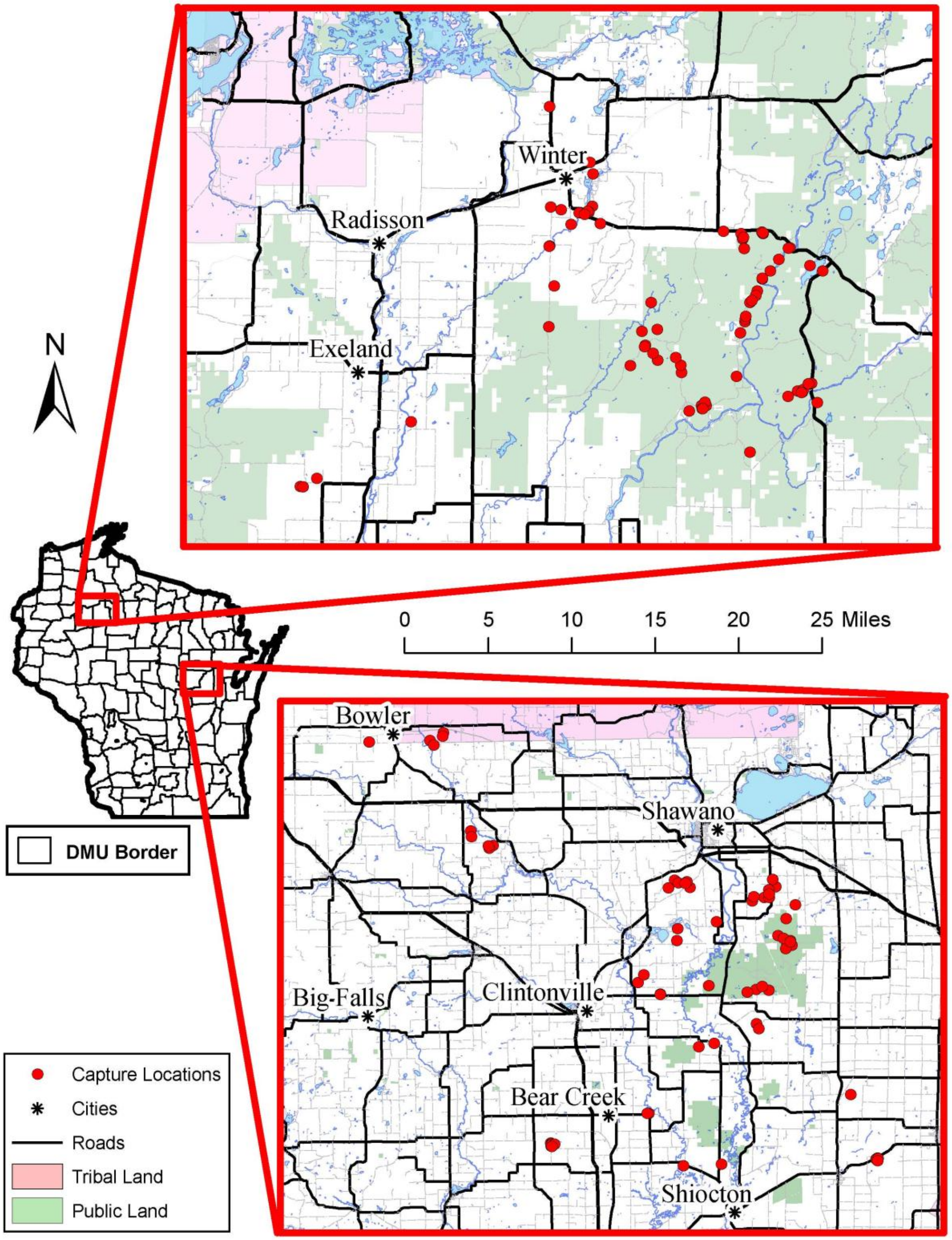

Figure 1. White-tailed deer study areas are located in northern (Sawyer, Price, Rusk counties) and eastcentral (Shawano, Waupaca, Outagamie counties) Wisconsin, 2010–2015. Thick red lines delineate approximate study area boundaries and red circles denote winter 2011 adult deer capture locations.

Figure 2. Adult female (upper left) and adult male (lower left) white-tailed deer captured and fitted with radio collars (right) in the Flambeau River State Forest, Winter, Wisconsin, USA, winter 2011.

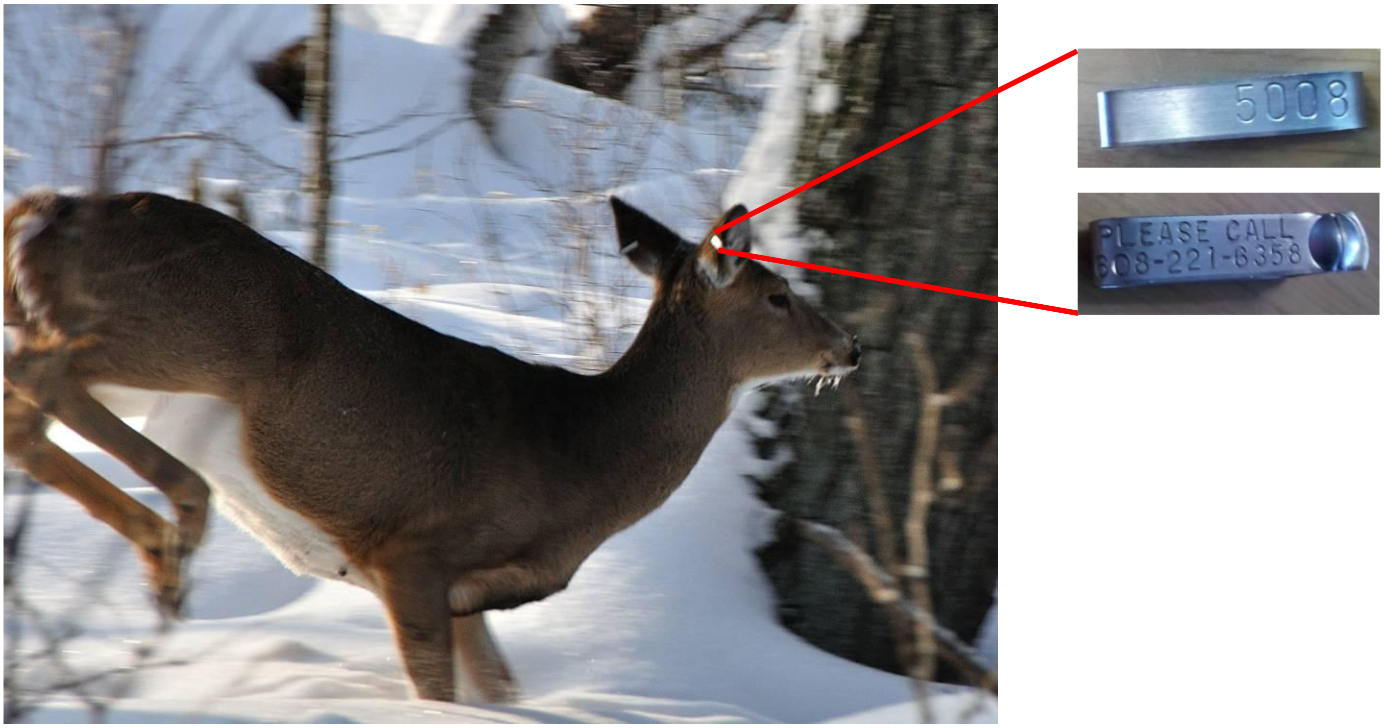

Figure 3. Ear-tagged adult female white-tailed deer captured in the Flambeau River State Forest, Winter, Wisconsin, USA, winter 2011.

Figure 4. Vaginal implant transmitter (VIT) implanted in adult female white-tailed deer in northern (Winter) and eastcentral (Shawano) Wisconsin, USA, winter 2011. VITs were implanted in 83 adult female deer (46 eastcentral farmland, 37 northern forest) for subsequent use in facilitating fawn searches during mid–May through mid–June 2011.

Figure 5. White-tailed deer fawn captured and fitted with ear tags and expansion breakaway radiocollar in eastcentral Wisconsin, USA, May 2011.

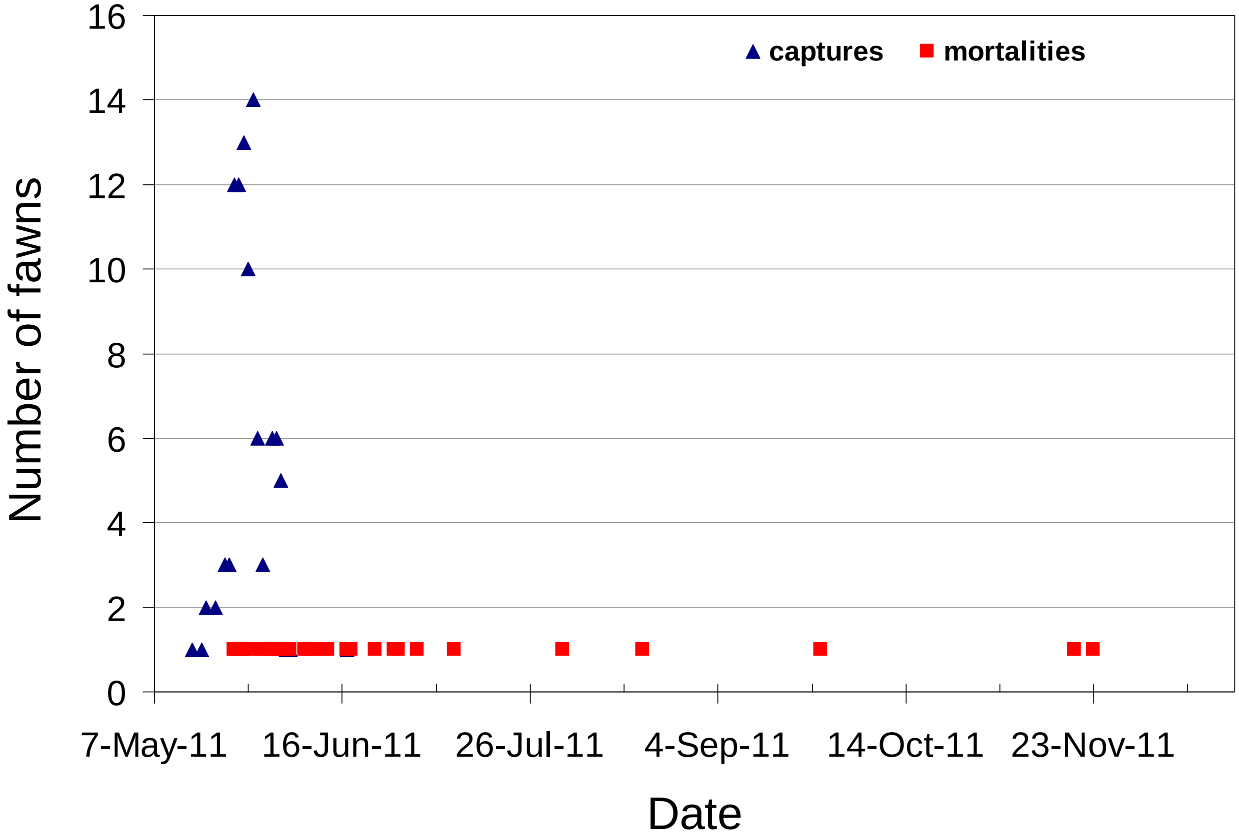

Figure 6. Capture (n = 104) and mortality dates (n = 38) of white-tailed deer fawns equipped with expandable radiocollars, northern and eastcentral Wisconsin, USA, 24 May – 31 December 2011.

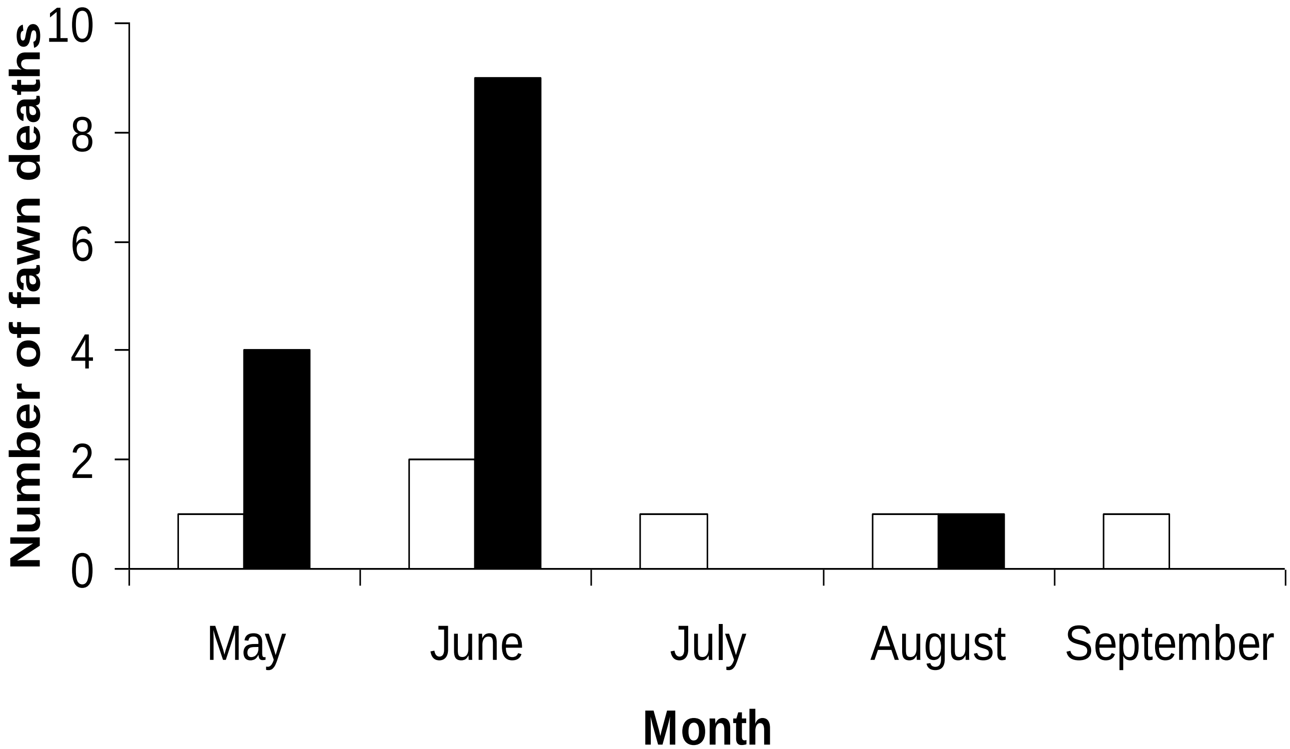

Figure 7. Predation events by month of radiocollared white-tailed deer fawns in northern (black bars) and eastcentral (white bars) Wisconsin, USA, May–September 2011.